5/PRTS
10/527466
DT15 Rec'd PCT/PTO 11 MAR 2005
PCT/DE2003/002996
English Translation

Dismountable Bridge

This invention relates to a dismountable bridge, i.e., a portable bridge for mobile use according to the preamble of Patent Claim 1.

The structures of dismountable bridges should have only as much mass as is absolutely essential for the specific application. This is important in particular when the bridges are to be transported by air freight to their site of use.

This means that the bridge must be designed so that the highest possible utilization of material is achieved in any load case and no components that carry little or no load need be carried as dead weight.

Swiss Patent **CH 336 183** discloses a pyramidal supporting structure that can also be used for a bridge. Several connected pyramidal supporting structures form a framework beam with a triangular cross section, with lower chords running through the two lower corners, which are at the same level, and an upper chord running through the upper corner.

German Patent **DE 40 00 987 A1** discloses a bridge building method for a composite beam bridge with a concrete roadway on a steel supporting structure. The individual prefabricated concrete parts of the roadway which have previously been positioned on the bridge abutment in the axis of the bridge are inserted into their installed positions, one after the other, via the steel supporting structure and then are joined to concrete poured in place without a gap.

The object of this invention is to create a bridge consisting of a few weight-optimized components, with each component being fully tied into the load-bearing capacity of the bridge when assembled.

This object is achieved with the bridge according to Patent Claim 1. Advantageous embodiments of this invention and a method for construction of the inventive bridge are the object of additional claims.

The inventive bridge includes lane girders, which are designed as framework beams with a triangular cross section, with lower chords running through the two lower corners, which are at the same level, and an upper chord running through the corner, and roadway slabs which form the roadway of

the bridge. The roadway slabs are placed on the upper chord. Connecting means are provided with which the upper chord can be connected to the roadway slabs in a non-positive manner and with shear strength.

Because of this type of construction, the lane girders are reinforced by the roadway slabs which are joined in a non-positive manner with shear strength and are laid on top of them. Therefore the lane girders can be designed very easily because the upper chord cross section, which is actually needed, is created only together with the roadway slab, which is joined rigidly and absorbs the longitudinal forces.

The minimized cross section of the unreinforced lane girder yields advantageous torque conditions for construction of the bridge, permitting the use of a lightweight laying device with only a few counterweights.

The bridge consists of only a few individual parts and can be laid very rapidly by means of mechanized construction equipment.

In a particularly advantageous embodiment of the inventive bridge, several hinge lines are provided on the individual roadway slab sections in the longitudinal direction of the bridge, so that the roadway sections can be folded together. The dismantled bridge can thus be stored in a manner that is optimal in terms of volume and thus is suitable for shipping by air freight.

The weight-optimized design of the bridge as well as the collapsible roadway slab sections permits air freight shipping in all conventional air-freight planes.

Typical spans of the inventive bridge are in the range of 25-30 meters.

The internal static connection of a lane girder is preferably implemented in an optimal manner in terms of weight by undetachable compounds (e.g., welding, riveting). The assembly of the bridge is thus possible with a minimal number of compound elements. There are no loose elements that could get lost easily in the terrain when there is rain, ice and/or snow or in the dark.

The framework of the lane girder preferably corresponds to the definition of framework according to Cremona. It is defined by the condition

$s=2*n-3$ where s = number of bars and n = number of nodes. Such a framework can be designed optimally with regard to weight and flexural rigidity.

In addition to ferrous materials, suitable materials for the bridge components include in particular aluminum and fiber-reinforced plastic (carbon fiber-reinforced plastic).

This invention is explained on the basis of exemplary embodiments with reference to the figures, in which:

FIG 1 shows an inventive bridge in cross section (section across the longitudinal direction of the bridge);

FIG 2 shows a detail of the non-positive connection with shear strength of the upper chord and the roadway slab in two sections parallel and transversally to the bridge longitudinal direction;

FIG 3 shows a detail of another embodiment of the non-positive and rigid connection of the upper chord and the roadway slab in two sections parallel and transversely to the longitudinal direction of the bridge;

FIG 4 shows a roadway slab section in the collapsed state for shipping of the bridge and in the partially unfolded state;

FIG 5 shows a diagram of the method of erecting the inventive bridge in two snapshots (side view).

FIG 1 shows an inventive bridge in cross section. It has two lane girders 3 with a triangular cross section, composed of one or more lane girder sections in the longitudinal direction of the bridge. The lane girders are each framework beams (diagonal bars 1), with a lower chord 4 being provided in the two lower corners and the upper chord 5 being provided in the upper corner of the cross section. The two lane girders are connected by transverse couples 2, which ensure that the two lane girders 3 will be parallel. The upper chord is of such dimensions that it is capable of absorbing the tensile forces from the bridge erecting process.

The upper chords are designed so that they permit a non-positive and rigid connection to the roadway slab 6 which is placed on the upper chords 5 of the lane girders 3.

The non-positive connection with shear strength between the roadway slab 6 and the upper chord 5 can be accomplished in a first embodiment by pusher rods 9 that transmit tensile and compressive forces. FIG 2 shows two pusher rods 9 arranged in pairs symmetrically with a horizontal central axis. A connecting element of the pusher rod is labeled as 91. For an optimum transmission of tensile and compressive forces, the two pusher rods 9 should be arranged preferably at an acute angle to the plane of the roadway.

The longitudinal force transmission between the roadway slabs themselves is accomplished by the footing of the slab cross-sectional areas at the ends (bending side to which pressure is applied).

Alternatively, the rigid and non-positive connection between the roadway slab 6 and the upper chord 5 may be implemented by a special flange element 8 (FIG 3). In doing so, the upper chord 5 and the roadway slab 6 are compressed by a chucking device 81, 82, 83. Between the upper chord 5 and the roadway slab 6, a shear-force-transmitting intermediate piece 84 which is three-dimensionally structured on one side (e.g., having teeth or grooving) is provided and is pressed on its toothed side against a second plastifying and shear-force-receiving intermediate piece 85. By pressing the toothed side onto the second intermediate piece 85, plastic deformation of the latter occurs. The surface structure of the structured intermediate piece 84 is impressed upon the second intermediate piece so that in this area a form-fitting connection is achieved between the two intermediate pieces 84, 85. Preferably ferrous materials, steels, sheet metal having good plastic workability may be used as the materials for the plastically deformable intermediate 85. By solving the tension rig 81, 82, 83, the connection of another rig can be released again. The intermediate piece 85, once deformed, can be replaced by a new one for the next construction of a bridge so that an optimum sheer strength is always achieved.

FIG 4 shows a section of the roadway slab 6 in the shipping position. There are two hinge lines 10 in the bridge span direction dividing the roadway slab 6 into an inside roadway slab element 61 and two outer roadway slab elements 62. The roadway slabs can be collapsed along the hinge lines 10 to yield suitable dimensions for air freight.

A construction method adapted to the design of the inventive bridge is illustrated in FIG 5.

The first illustration in FIG 5 shows a snapshot according to which two roadway slab sections 61, 62 have already been linked together and connected to the lane girders 3. A third roadway slab section 63 is pushed over the lane girder 3 using the guide elements 7 supported on rollers. The guide system 7 may be designed easily and as a multifunctional system for lifting, lowering and guiding. It may be advanced manually or by manually operable drive devices such as cable winches.

The second illustration in FIG 5 shows the completely assembled bridge after all four roadway slab sections 61 through 64 of the bridge have been erected and connected one after the other to the lane girders 3 in a non-positive manner with sheer strength.

Specifically, the construction procedure takes place as follows: In the first step the two lane girders 4 of the bridge are erected as cantilevered structures. As soon as the two lane girders 3 have been set up on the two shores, the first roadway slab section 61 is unfolded and placed on the upper chords 5 of the two lane girders 3 on this end DE of the bridge. Guide elements 7 (arranged on the roadway slab section 63 in FIG 5; this roadway slab is being installed at the point in time illustrated in this figure) are present on the roadway slab section; by means of these guide elements, the roadway slab section 61 is then advanced over the lane girders 5 to the other end JE of the bridge where the roadway slab section 61 is joined to the lane girders 3 in a non-positive manner with sheer strength so that the roadway slabs can be tied into the longitudinal force flow. Then the next roadway slab section 62 is advanced in the same way over the lane girder 3 and folded up with the roadway slab section 61 installed previously and also connected to the lane girders 3 in a non-positive manner with sheer strength. This procedure ensures in particular that the roadway slab is optimally adapted to the bending line of the lane girder. Erecting the roadway slab sections described here is continued until reaching the end of the bridge on this side.

The roller-supported conveyance system may also be utilized to, for example, replace a defective segment of roadway of a bridge that has already been constructed. The connections with sheer strength to the lane girders are manually released and roadway slabs can be advanced forward and in reverse again in the required order.

The method described here is optimally adapted to the construction of the inventive bridge and permits very rapid construction of the bridge.

The number of bridge sections used depends on the span required and amounts to at least one. The bridge depicted in FIG 5 consists of four bridge sections, for example.